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Report No. NADC-90103-70



# WHITE PAPER ON PROJECT SUPPORT ENVIRONMENT STANDARDS

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**OCTOBER 1, 1990**

**PROGRESS REPORT**
**Period Covering August 1989 to September 1990**
**Task No. X19760000H**
**Program Element No. 64574N**
**Project No. A109706**

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Prepared for
SPACE AND NAVAL WARFARE SYSTEMS COMMAND
Washington, DC 20363-5109

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SECURITY CLASSIFICATION OF THIS PAGE

# REPORT DOCUMENTATION PAGE

Form Approved
OMB No 0704-0188

| | |
|---|---|
| 1a REPORT SECURITY CLASSIFICATION<br>Unclassified | 1b RESTRICTIVE MARKINGS |
| 2a SECURITY CLASSIFICATION AUTHORITY | 3 DISTRIBUTION / AVAILABILITY OF REPORT<br>Approved for Public Release; distribution is unlimited |
| 2b DECLASSIFICATION / DOWNGRADING SCHEDULE | |
| 4 PERFORMING ORGANIZATION REPORT NUMBER(S)<br>NADC-90103-70 | 5 MONITORING ORGANIZATION REPORT NUMBER(S) |
| 6a NAME OF PERFORMING ORGANIZATION<br>Systems And Software Technology Department<br>6b OFFICE SYMBOL (If applicable)<br>7031 | 7a. NAME OF MONITORING ORGANIZATION |
| 6c. ADDRESS (City, State, and ZIP Code)<br>NAVAL AIR DEVELOPMENT CENTER<br>Warminster, PA 18974-5000 | 7b ADDRESS (City, State, and ZIP Code) |
| 8a NAME OF FUNDING / SPONSORING ORGANIZATION<br>SPACE AND NAVAL WARFARE SYSTEMS COMMAND<br>8b OFFICE SYMBOL (If applicable)<br>SPAWAR-324 | 9 PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER |
| 8c. ADDRESS (City, State, and ZIP Code)<br>Washington, DC 20363-5109 | 10 SOURCE OF FUNDING NUMBERS<br>PROGRAM ELEMENT NO: 64574N<br>PROJECT NO: A109706<br>TASK NO: X19760000H<br>WORK UNIT ACCESSION NO: 109706 |

11 TITLE (Include Security Classification)

White Paper on Project Support Environment Standards (U)

12 PERSONAL AUTHOR(S)
Oberndorf, Patricia A.

| 13a TYPE OF REPORT | 13b TIME COVERED | 14 DATE OF REPORT (Year, Month, Day) | 15 PAGE COUNT |
|---|---|---|---|
| Progress | FROM 8/89 TO 9/90 | 1990 Oct 1 | 23 |

16 SUPPLEMENTARY NOTATION

| 17 COSATI CODES | | | 18 SUBJECT TERMS (Continue on reverse if necessary and identify by block number) |
|---|---|---|---|
| FIELD | GROUP | SUB-GROUP | Software Engineering Environments, Project Support Environments, Interfaces, Standards, Next Generation Computer Resources (NGCR) |
| | | | |
| | | | |

19 ABSTRACT (Continue on reverse if necessary and identify by block number)

A Project Support Environment Working Group (PSEWG) is to be established under the Next Generation Computer Resources (NGCR) program to investigate standardization of PSE interfaces. This report documents several issues that the group will face and suggests positions to be taken. It proposes an approach and organization for the joint Navy/industry PSEWG. It documents a baseline of available sources of relevant technology, including Point of Contact information.

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|---|---|
| 20 DISTRIBUTION AVAILABILITY OF ABSTRACT<br>☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT ☐ DTIC USERS | 21 ABSTRACT SECURITY CLASSIFICATION<br>Unclassified |
| 22a NAME OF RESPONSIBLE INDIVIDUAL<br>Patricia A. Oberndorf | 22b TELEPHONE (Include Area Code) 215-441-2737<br>22c OFFICE SYMBOL 7031 |

DD Form 1473, JUN 86 *Previous editions are obsolete*

SECURITY CLASSIFICATION OF THIS PAGE

S/N 0102-LF-014-6603

Unclassified

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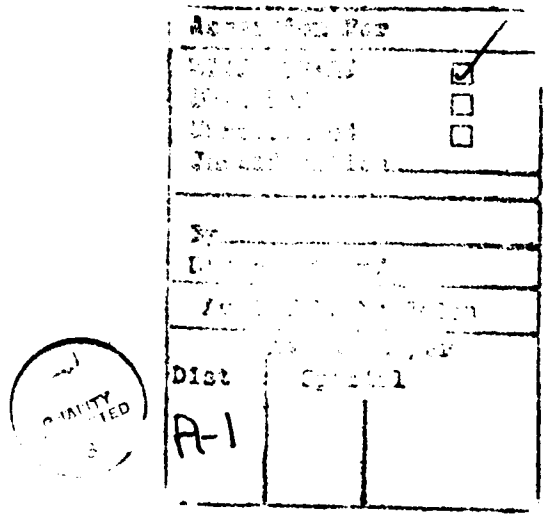

White Paper

on

Project Support Environment Standards

March 1990

## 1 Introduction

The Next Generation Computer Resources (NGCR) Program is to provide the standardization of Navy mission critical computer interfaces and computer component interfaces. With these standardized interfaces, industry will be better able to provide computing resources that meet Navy needs. The interface standards are to be widely available (i.e., non-proprietary) and, if possible, widely utilized within industry.

The Project Support Environment Interface Standard (PSEIS), the subject of this paper, is one of the set of standards which is essential to the timely and cost effective acquisition of the majority of the next generation of Navy mission critical computing systems. PSEIS will assist the Navy in efficiently providing systems which address a wide range of performance levels, compatible computing service levels, and functionality levels.

The purpose of this paper is to articulate initial thinking regarding the issues facing the NGCR Project Support Environment Working Group (PSEWG) and to provide a starting point for PSEWG discussions when the group is initiated in FY-91. This paper is a required deliverable under current NADC tasking for NGCR.

## 2 Scope

The NGCR interface standards, while being incrementally developed, are to be sufficiently in place so that the Navy can begin acquiring systems utilizing those standards by 1998.

The period of PSEI standards development begins in FY91 and continues through FY98. The initial PSE standards will be available for use in acquisitions starting in FY95.

The initial range of applications includes as many types of computing as possible from just above the single dedicated processor to as high as can be obtained on networked, heterogeneous, modularized backplane bus architecture computing systems. Networking is to be done using NGCR LAN standards and, as appropriate, other MIL-STD links.

# 3 Issues

## 3.1 Technical

There are a number of levels at which NGCR can strive to establish useful PSE interface standards. Most of them are not addressed well by current industry standards. Therefore it will be necessary to carefully choose the objectives of this effort.

There are several areas of technical concern which should be considered during the development of a set of specifications for a set of project support environment interface standards. Some of the major areas of concern are listed below with a brief description. They are considered essential characteristics of the support environment.

The following list is not in any particular order.

### 3.1.1 Possible Goals

A number of different goals for the PSEI are possible. Some of them, along with assessments of their praticality for this effort, are:

1. Being able to "mix & match" tools from different vendors. This is definitely a goal. It is in the Navy's best interests to be able to acquire tools competitively from a variety of sources.

2. Minimizing training. This is also very desirable. It is achieved by standardizing those aspects of the PSE which affect the ability of a PSE implementer (i.e., tool- or framework-writer) or user (e.g., a programmer using the PSE to generate code for an application) to move from one NGCR-conforming PSE to another. This consideration expands the concern of the standardization beyond just the tools and into the framework and user interface aspects.

3. Maximizing ease of transition to PDSS. This is poorly addressed in today's scheme of handing things off from a contractor to a Navy agency or from a Navy laboratory to a PDSS agent for system maintenance. It is an important concern and needs to be addressed by these standards. This suggests an emphasis on generation and delivery of project databases and commonality among facilities used by contractors, laboratories, and maintenance activities.

4. Maximizing tool commonality (e.g., "common buys") vs. achieving a higher level (e.g., framework) of standardization vs. both. A current approach to standardization of Navy PSEs takes advantage of the economy that can be had by the laboratories agreeing to purchase certain useful tools cooperatively; this eliminates all of the redundant decision-making, evaluation, and expense of fees and royalties. However, it would be quite difficult to bring together as large a community as the entire Navy under such a scheme, largely because of the great diversity. It would be better to establish the common interfaces on which such a strategy could be based than to essentially try to standardize on certain jointly agreed tools; with common interfaces, certain Navy sub-communities who found advantage in such a "common buy" could do so even more readily than today.

5. Achieving host interchangability. It is clear that the Navy needs to be independent of various hardware vendors. In particular, it is desirable for a Navy activity to be able to change from one host system to another without negative impact on all of the PSE investment they have made. In addition, the interfaces should not be dependent on the use of hardware from only one vendor.

6. Attaining a particular level in the SEI assessment. It is not clear to what extent the levels in the SEI assessment affect the PSE interfaces. But to whatever extent they do, the PSE interfaces should not preclude an organization's ability to achieve the highest level.

7. Achieving compatibility with other NGCR standards. It is very important that all of the NGCR standards cooperate and appear compatible to users. For the PSEI, this is especially important in its relationship with the OSIF, since most of its interaction will be with the OS.

3.1.2 Scope

The scope of the environment (and therefore of the resulting standards) also needs to be carefully considered.

1. Is the PSE only intended to support the generation of software, or should it be able to support other aspects of system development as well, such as CAD/CAM? Several efforts point to the fact that there is very little difference between the underlying support required for the support of software and that required for the support of hardware and general systems work. In fact, the ability to provide PSEs which fully support both software and hardware design and development would be very positive, as it would provide an opportunity for true systems engineering to take place in a common environment. Activities that are necessary for good systems engineering, such as hardware/software trade-offs, could then become a part of normal systems development work.

2. Should the programming languages/paradigms supported be only for Ada, or should a variety of languages be supported? Ada is the language of choice for MCCR for the DoD, so it must certainly take a prominent place in the PSE. However, there are legitimate reasons for including a variety of languages. Many tools that will be available off-the-shelf in the near future will be written in languages other than Ada, but the Navy needs to be able to take advantage of these. In addition, some applications in the future will use special-purpose languages, such as artificial intelligence and fourth generation languages, which the PSE will also be called upon to support.

3. What is the application mix which is to be supported? There is a wide range of Navy applications, from those resembling business systems to those that typify the extreme in demands for such attributes as security, fault tolerance, and hard-real-time. The PSE must be able to support this range of applications. That implies that various suites of tools, including those that place an emphasis on space/time trade-offs for small platforms, will be required, and the characteristics of the PSEs which can be built using the PSEIF will have to be able to change to meet these needs. The PSEs must be flexible and evolvable, so the PSEIF must also display these attributes.

3.1.3 Level/Extent of Standardization

There are many different ways in which PSE standardization can be approached. Among them are:

1. Choose a standard set of tools. This has the advantage of achieving economies at purchase time, but it has the liability of locking in what could quickly become outdated technology and of locking in the vendors of the chosen products. These liabilities are contrary to the objectives of NGCR.

2. Choose an OS, DBMS, etc. This has the advantage of establishing a common platform, but does not address all of the other functionality which it takes to make a true PSE. It also has the liabilities discussed above for choosing a standard set of tools.

3. Standardize on interfaces which are key to the PSE framework. The framework consists of those aspects of a PSE which exceed the hardware/software "platform" and the tools which do the specific functions. It encompasses a central data repository for the retention of all project-related information and the means which can therefore be made available for integration of project management and technical process. This alternative is consistent with NGCR's approach of interface standardization.

The consensus of the community is that the best approach to PSE standardization is through the standardization of various interfaces. The exact identification of the interfaces which will be required to achieve the goals of NGCR in the area of PSEs will be one of the initial tasks of the PSEWG.

3.1.4 User Interface

The user interface has many different aspects, some of which are the subject of what might be appropriate standardization efforts (e.g., GKS, X-Windows) and some of which do not appear to be (e.g., consistent commands for common actions such as termination). The PSEWG must take care to identify the various aspects of user interfaces and to become familiar with relevant efforts. At the very least, the PSE standard must be capable of providing support for sophisticated color, bit-mapped, image-oriented graphics.

It should be noted that the NGCR program proposes to establish a Graphics Language standard for target applications, so one can consider whether or not this should be required to also be a part of the PSE user interface standardization. The recommendation is that the PSEWG first identify the graphics-related needs of the PSE; then, if the NGCR Graphics standard appears to apply to the PSE as well, choosing it might be advantageous. But no *a priori* determination should be made that the two must be compatible.

3.1.5 Information Management

Information management is critical to a PSE. But there is little understanding yet of what this entails, and there are even fewer existing or proposed standardization efforts which attempt to address this. Certainly it is related to questions of database management, but it goes far beyond what a typical database management system can provide alone.

There are also issues regarding what level of granularity of information should be retained in the information management system. On the one hand, projects have the need to retain gross level objects such as source code programs and design documents. On the other, projects (particularly individuals within projects) have the need to retain detailed information about parts of these larger objects, such as the relationship between a module and its test cases or between a design element and the requirement which it fulfills. These varying levels of granularity raise the question of whether a single common information management system should be expected to address all of them. Perhaps a bi-level system should be investigated in which objects at the gross level are at the higher level of the information management system and the detailed information about elements of those gross-level objects are contained in a related information management system which might be better capable of supporting the demands of the lower-level, finer-grained objects and operations.

As with the Graphics, the NGCR program proposes to establish a Data Base Management System standard for target applications, so one can consider whether or not this should be required to also be a part of the PSE information management standardization. The recommendation is that the PSEWG first identify the information-related needs of the PSE; then, if the NGCR DBMS standard appears to apply to the PSE as well, choosing it might be advantageous. But no *a priori* determination should be made that the two must be compatible.

3.1.6 Methodology Support

Since many users equate a PSE with the tools it contains and these often embody support for specific methodologies, the ideas of what the environment should do in the way of methodology and what the tools can do are often confused. A PSE should be capable of supporting any responsible methodology which a project might choose to employ, provided the project can acquire the tools necessary to support the chosen methodology. However, beyond this, there are some general ways in

which a PSE can be more or less conducive to various approaches. For example, it could be as generic as possible or it could pre-determine that, although a variety of approaches are allowed, they must all be some variation on transformational programming. It is believed that such a restriction would be unnecessary and counter-productive, since no definitive answer has materialized as yet to the question, "what is the best methodology?" However, those deciding on the interface standards to be adopted should be careful not to adopt any which, either individually or in combination, inadvertently limit the options.

Another aspect of methodology is support for such paradigms as re-use and automatic generation of code. Both of these have important roles to play in the development of future Navy systems, so both should be accommodated but neither should be forced on everyone.

Finally, the PSE is in a unique position to assist project managers in the planning and tracking of project plans and the enforcement of project-chosen process guidelines. While it is possible to include in the PSE standards one for a standard overall project process, that is undoubtedly premature. But the PSE should be capable of accommodating a variety of such processes and of enforcing those aspects which the manager choses to have it enforce.

### 3.1.7 Integration

Overall integration of tools, data, and users is one of the key functions of the PSE. It can be achieved at a variety of levels, all of which are important. One of the key ones is integration of data and process, such that information flows smoothly between tools and between technical project workers and the project management. Another key one is that of integration of style, particularly of the user interface across a variety of tools and capabilities. A third is the integration of tools from a variety of sources into the PSE in such a way as to provide a seamless environment while still taking advantage of products from a variety of vendors. All of these integration goals place extraordinary demands on the PSE and on the interfaces which are standardized.

### 3.1.8 Transition from Today's Environments

Transition from the state-of-the-practice of today to the system generation approaches which will be guided by NGCR is an important consideration in all aspects of the NGCR program. Two particular aspects are important to the PSE. One is the capture of existing significant systems of tools, most particularly Ada compilation systems. Many tools which might do quite well for the Navy are currently available, but not in the context of true PSEs. It must be possible to move these current tools into PSEIF-based environments quickly and economically in order for the marketplace to find it feasible to support (i.e., market tools and capabilities which are compliant with) the NGCR standards. This is likely to place some constraints on the interfaces which can be standardized.

Another consideration for transition is how to help organizations move from existing Navy environments (e.g., ALS/N) to new NGCR-based environments. Such transition scenarios must be well-understood before decisions can be made regarding PSE interface standardization.

It is likely to be more effective to think in terms of transition and to plan from the start to furnish appropriate transition guideline documents than it is to let too many of these considerations hamper the interfaces themselves. Transition is not the top-priority concern for the PSE, but some thinking about it at the beginning is likely to save a lot of trouble at the end.

### 3.1.9 Distribution / Networking

Distribution and networking appear to be a fact-of-life in todays' environments and would seem to have an ever-increasing role for the future of PSEs. But distribution can take several different forms, and the PSEWG needs to be aware of them.

One concern is the difference between the "distributed workstation" vision, where everyone has a workstation at their desk and there are no large mainframes involved, and the "mainframe with intelligent terminals" vision, which more closely resembles some of the software support capabilities of today. Both are and will continue to be important, but assumptions associated with each one must be considered together or incomplete interfaces will result.

As with the Graphics and DBMS, the NGCR program has already taken steps to establish a Local Area Network standard (called SAFENET) for target applications, so one can consider whether or not this should be required to also be a part of the PSE standardization. The recommendation is that the PSEWG first identify the network-related needs of the PSE; then, if SAFENET appears to apply to the PSE as well, choosing it may be advantageous. But no *a priori* determination should be made that the two must be compatible.

Another interesting question raised by the other NGCR standards concerns the existence of the backplane standard, based on Futurebus+. What, if any, impact will this have on the PSE and on the architectures on which it will depend? To what extent should a backplane standard be taken into account in the derivation of the PSE interfaces? These questions and others like them remain to be dealt with and resolved for the PSEIF.

In addition to the issues raised by a standard backplane, one must consider other sorts of hardware technology which appear to be coming up on the horizon and determine whether or not they need to be taken into account when standardizing PSE interfaces. Examples of these are supercomputers and array/parallel processing. Again, these must be considered, and in two ways for the PSE: both for their effects as elements in the PSE host environment and as parts of the target configurations for which the PSE will help develop systems.

### 3.1.10 Heterogeneity of Functions / Processing Elements

The PSE must be implementable on a heterogeneous platform of hardware in a variety of architectures and configurations to allow for the incorporation of new technology and new system development requirements. This supports one of the NGCR objectives which is to avoid dependencies on proprietary products. Heterogeneity should be supported at many levels. Support for standard programming languages such as Ada increases program portability. Possibly inconsistent object formats present a problem that needs to be considered. The ability to convert data representations between a variety of targets is an important consideration as well. Many other areas of the PSE also need to be considered in terms of heterogeneity.

### 3.1.11 Recovery / Damage Control/ Fault Tolerance / Survivability

Although Fault Tolerance is not as vital a consideration in the PSE as it is in the target environment, it is still important and should be addressed by the PSEWG. Perhaps it does not affect so much the PSE interfaces themselves as it does the choices which one makes in selecting the characteristics of the underlying platforms. The PSE must also be capable of supporting these characteristics in the target applications which it is used to generate, so these considerations may have some additional impacts on the PSE interfaces.

### 3.1.12 Security

Since the PSE must be able to support the generation of secure systems, it must be able to protect its own integrity from inadvertent or malicious misuse. The PSE should support multi-level security within a singular PSE as well as across a distributed architecture. The security mechanism should conform to available and evolving DoD standards as appropriate. Security is a particularly difficult issue to solve when coupled with the response requirements of interactive systems.

### 3.1.13 Application-specific Environments

Although the PSE standards need to be generic, projects will sometimes find the need to tailor their environments to the specific needs of a particular application area. The PSE standards should recognize this and facilitate it. Generally this applies to the choice of tools, but it can be reflected in other aspects such a support for the project-chosen process and for re-use of application-specific modules.

### 3.1.14 Relationship to OS

One of the most important relationships that the PSE has with the other NGCR standards is with the operating system. Some desirable operating system characteristics have already been identified which require the PSE's support in order to realize. Chief among these is the desire to have configurable implementations of the operating system interface standard. This entails the population of a library with NGCR operating system interface standard-compliant operating system elements which can be combined in a variety of ways to meet the peculiar needs of a given application; for example, although modules which provide full support for a file system would be present in the operating system library, an application which did not have any need for a file system would need to be able to configure an operating system implementation which did not include these modules and would still provide all of the other aspects required for that application.

In addition, close communication and cooperation between the operating system and the PSE must be possible in order to achieve down-loading of application programs to the target and target debugging.

## 3.2 Policy

It is the NGCR policy to adopt existing commercial standards whenever possible. The world of PSE-related standards is quite bewildering, as there are a number of standards which would seem to be applicable, but it is clear that there is no common vision coordinating them, such as the OSI reference model does for the world of LANs. This makes it extraordinarily difficult to determine either which standards might be adopted together to achieve some goal or where there are holes or gaps where no standardization activity has started. It will be a critical step in the establishment of the PSE interface standards first to establish a reference model which can help to bring some sense out of the chaos and then to unravel the maze of efforts and put them into some context with respect to this model.

It will also be important for NGCR to carefully consider what the Navy's policies should be with respect to the mandate of the adopted PSE interface standards. A "carrot-and-stick" approach (as opposed to a strictly "stick" one) would undoubtedly be most effective in an area such as the PSE in which there is a great deal of change happening and very little maturity of any current products or efforts.

## 4 Approach

The primary objective of the PSEWG will be the development of a set of interface standards for project support environments. In support of this objective, it will also be necessary to generate a variety of accompanying documents, including at least the following:

operational concept/reference model

requirements (with rationale)

rationale for the set of interface standards

user and implementer guides

It will also be critical to the success of the effort to be able to demonstrate the viability of the proposed standard through prototype implementations. As the NGCR budget currently stands, no money is planned for such an effort, so it must be achieved through cooperation with other projects and cooperative use of available resources.

The PSEWG should have primary responsibility for all decisions made with respect to the project support environment interface specification and accompanying products. It should be structured analogously to the existing NGCR working groups, with a Navy Chairman and Co-Chairman and a mixture of government, university and industry participants. Meetings should be at least quarterly, possibly supplemented by more frequent meetings of individual subgroups.

Before the PSEWG is first convened, the Navy laboratories, under the leadership of NADC, will do further planning. This planning should further develop and elaborate on the suggestions presented here for organization, issues and products. The first PSEWG meeting should be attended by only government personnel. This is to ensure coherence and direction of the government objectives and requirements prior to exposure of these to the general community. Such an initial government meeting can be pursued in parallel with the solicitation of initial information from industry and universities.

Government participants should be solicited from at least each of the Navy laboratories and PDSS activities. Other sources of relevant expertise should also be investigated and tapped if possible, including Navy testing activities, development and PDSS organizations from the other services, and other federal agencies, such as DARPA, NASA, JIAWG, and NIST.

Industry and university participants should be solicited both from known sources and through open solicitations such as in the CBD.

It should be assumed both that the government does not have sufficient qualified personnel by itself to successfully complete this project and that volunteers (whether from government, university or industry) cannot be expected to be sufficiently regular or dependable. Thus plans should be made to have two kinds of support contracts. One would be administrative/secretarial in nature, the other technical. The technical "contract" could in fact be several contracts, each for a different sort of expertise, or it could be one contract awarded to a sufficiently diverse team.

The PSEWG should be free to form subgroup structures as they are needed. These will most likely respond to different needs at different stages in the life of the PSEIS activity. Initially it is suggested that a subgroup structure be formed which is oriented around the different kinds of issues presented in the last section. These issues can be grouped in ways which afford an opportunity for participants with similar interests and backgrounds to discuss a logical group of related issues to better describe them and to get a better understanding of their role in the entire PSEIS effort. The objective of this initial organization would be to articulate and understand the reference model which would be

used for the remainder of the group's activities. Later it is likely that a subgroup structure oriented around the products or around a set of orthogonal concerns would be more productive. One such structure might have a subgroup for each of Requirements, Available Technology (to meet the emerging requirements), and Approach (to formulate processes and considerations to be used in proceeding with the work).

One of the first activities of the PSEWG should be the formulation of a charter. This activity will serve to focus and channel the thinking of the participants. Any subgroups should also formulate charters for their special objectives.

## 5 Available Technology

No currently existing standard adequately addresses all of the PSE concerns discussed above. However, there exists a great deal of PSE-related expertise in government, universities and industry. The level of work being done by these various groups ranges from purely theoretical to attempts to produce products. The following is meant to highlight some of the more extensive work being done and is by no means to be considered a complete list. These groups could potentially provide valuable input to the development of PSEIS.

### 5.1 Technical Groups

Naval Air Development Center (NADC)

NADC has been at the forefront of PSE related activities for over 15 years. One of the first operational PSEs to demonstrate some of the features advocated in earlier sections of this paper was the NADC Facility for Automated Software Production (FASP). Several project-tailored versions of the FASP are still in use today. In addition, NADC was chosen by NAVAIR to lead its effort to increase PSE-related commonality among the Navy laboratories which most often work on NAVAIR projects. Called the NAVAIR Software Engineering Environment (NASEE), this project concentrates on solving many of the real PSE problems which need to be addressed in the near term. NADC personnel are also involved in various capacities in a wide variety of other PSE- related activities. Point of contact: Patricia Oberndorf, Code 7031, NADC, Warminster, PA 18974-5000, (215)441-2737.

Naval Ocean Systems Center (NOSC)

NOSC also has a long history of involvement in PSE projects and research. Earlier efforts have included one of the first attempts to set out requirements for a PSE, as part of the Software Engineering Automation for Tactical Embedded Computer Systems (SEATECS) project. Until recently, NOSC was also responsible for the ONT Computer Block Program, which includes a significant portion of the Navy's PSE research activities. Point of contact: Linwood Sutton, Code 413, NOSC, San Diego, CA 92152-5000, (619)553-4082.

Naval Surface Weapons Center (NSWC)

NSWC is the primary support lab for the AEGIS tactical real-time system. As such, they have a great deal of interest and expertise in PSEs as they are available today and what the needs are for their imprqovements in the future. Point of contact: Daniel Green, NSWC, Dahlgren, VA 22448, (703) 663-4585.

Naval Underwater Systems Center (NUSC)

One of the groups at NUSC has been a principle contributor the Navy's Ada Language System/Navy (ALS/N) project. In addition, they are well-equipped and well-qualified to perform a number of experiments with respect to PSE issues. Point of contact: Tom Conrad, NUSC, Newport Laboratory, Code 2221, Newport, RI 02840, (401) 841-3846.

Rome Air Development Center (RADC)

RADC also has a long history of involvement in PSE projects and research. They were responsible for the Ada Integrated Environment (AIE), one of the first DoD projects to address Ada PSEs. They were also quite active in the DoD Software Technology for Adaptable, Reliable Systems (STARS) program and in the Ada Joint Program Office's (AJPO) Evaluation and Validation (E&V) Team, producing a significant PSE taxonomy for that team. Current work includes the Software Life Cycle Support Environment (SLCSE) project. Point of contact: Frank LaMonica, RADC, Griffiss Air Force Base, NY 13441-5700, (315) 330-2054.

CECOM

In the past, CECOM has done work in the area of DoD PSEs. Most notable is their effort to produce the Ada Language System (ALS). Point of contact: Dennis Turner, CECOM, Fort Monmouth, NY, (201) 554-4149.

National Aviation and Space Agency (NASA)

The National Aeronautics and Space Administration (NASA) Space Station project is working to field an elaborate space station facility in the 1990's. The system will be highly computer-dependent and places significant demands on the PSE. This group of people has been gathering information and experience for the last few years and would be a valuable source of insight into potential PSEIS issues and challenges. Point of contact: Ed Chevers, NASA Johnson Space Center, Houston, TX, (713) 483-4281.

National Institute for Standards and Technology (NIST)

NIST has initiated a series of workshops which is oriented towards determining a common reference model for environments and, using this model, determining those aspects whose needs appear to be met by standards and those which appear to need new work to achieve appropriate standardization. In addition, NIST has a long history of participation in appropriate standards activities and has a certain amount of influence with those organizations which are pursuing standards that could be used as a part of the PSEIS. Point of contact: William Wong, NIST, Gaithersburg, MD 20899, (301)590-0932.

Software Engineering Institute (SEI)

SEI is currently involved with a number of PSE-related projects. One of the more well-known ones is the work they have done to define a number of levels of achievement in the area of software engineering sophistication, resulting in a tool for assessing various organizations. The staff also includes a number of people well-known in the PSE arena. Point of contact: Larry Druffel, SEI, Pittsburgh, PA 15213, (412) 268-7740.

Kendall Square Research (KSR)

KSR is involved in several aspects of PSEs, including both tools and framework concepts. Point of contact: Kendall Square Research, One Kendall Square, Cambridge, MA 02139, (617) 494-1146.

Software Productivity Solutions (SPS)

SPS has been involved in a number of PSE activities since their formulation. These activities include participation on the AJPO's KAPSE Interface Team (KIT), developers of CAIS-A (see below), and the E&V Team. More recently, they have been involved in a project to derive an approach to environment assessment. Point of contact: Andy Rudmik, SPS, Inc., P.O. Box 361697, Melbourne, FL 32936-1697, (407)984-3370.

University of Southern California (USC) Information Sciences Institute (ISI)

USC-ISI has been pursuing modern high-payoff approaches and technologies for building advanced software environments. Much of their work has been concerned with radically new paradigms and supporting environments for the initial development and lifecycle evolution of software. They have extensive practical experience in evolution of approaches to construct software environments which are centered around databases. As a result, USC-ISI has developed both a technology and an associated methodology for constructing data-centered environments and systems. Point of contact: Bob Balzer, USC Information Sciences Institute, 4676 Admiralty Way, Marina Del Rey, CA 90292, (213)822-1511.

Other

There is other research and development in the area of PSEs. All of these groups, especially the ones mentioned above, have valuable insight into environment-related issues. In particular, most major vendors are quite concerned about how best to support current and future demands for more sophisticated support environments. Also included are the Microelectronics and Computer Technology Corporation (MCC) and the Software Productivity Consortium (SPC), both of which have engaged in varied forms of PSE-related research and development.

5.2 PSE Projects

STARS

The DoD STARS project has had many facets. Although early efforts resulted in various levels of requirements and specifications for a common environment, more recent efforts have emphasized participation of industry to produce a wide variety of tools (known as the Foundations effort) and three incarnations of software engineering environments which will further the technology required while incorporating existing standards whenever possible. The three prime contractors are IBM, Boeing and UNISYS. Point of contact: Dr. Jack Kramer, STARS Technology Center, Suite 317, Arlington, VA 22209, (703)243-8655.

JIAWG SEE

The Joint Integrated Avionics Working Group (JIAWG) has been charged with the responsibility of achieving a greater level of commonality between the avionics products of the three services, particularly the ATA, ATF and LHX. One aspect of this effort is to achieve some level of commonality between the environments in use on the three efforts. Standards have been taken into account in this. Point of contact: Ed Evers, General Dynamics Data Systems Division, 12101 Woodcrest Executive Drive, P.O. Box 27366, St. Louis, MO 63141, (314)851-8910.

NASA Space Station

(See NASA section in 5.1)

ARCADIA

The ARCADIA project is staffed by a number of participants from various organizations, including universities and companies, and is funded by DARPA. Its objective is to bring together many of the more modern environment concepts in order to provide advancement in the PSE area. Point of contract: Dr. Richard Taylor, Department of Information and Computer Science, University of California, Irvine, CA 92717, (714)856-6429.

EIS

The Engineering Information Station (EIS) is a project at AFWAL whose goal is to provide a workstation for the management of (hardware) engineering. Its concepts and results are very much in tune with the goals of the PSE. One aspect of the project is the establishment and promotion of relevant standards. In addition to AFWAL and Honeywell, contributing organizations include Xerox, TRW, MDAC, CLSI, and ASU. Point of contact: Cliff Erickson, Honeywell, (612)782-7496.

ALS/N

The ALS/N (Ada Language System / Navy) is the Ada compilation capability being developed for the Navy standard computers. The compilation capability is a part of a complete environment and is one environment in use in the Navy today. Point of contact: Bill Wilder, U.S. Navy, NAVSEA PMS-412, Washington, D.C. 20362-5101, (703)602-8204.

5.3 Related Technology

NASEE

NASEE is a NAVAIR project whose objective is to address some of the near-term needs of PSEs for NAVAIR systems. During its first phase, it has competitively selected a set of commercial tools which deal with aspects other than generating code and made them available throughout the NAVAIR laboratories as part of a common buy. Future plans include addressing questions such as integration and transition into full environments. Point of contact: John Bergey, NADC, Code 703, Warminster, PA 18974-5000 (215)441-3298.

Atherton Backplane

Atherton Technology has developed an integrated set of services oriented around a framework concept. That framework, both in concept and in detail, may have some applicability to the NGCR PSE. Point of contact: Bill Paseman, Atherton Technology, 1333 Bordeaux Drive, Sunnyvale, CA 94089, (408)734-9822.

Methods

Many different groups are working on various methods (and often tools to implement them) that address some part of the full spectrum of lifecycle support. Although there are far too many to list individually here, such efforts may have some bearing on the directions taken for PSE interface standardization.

Software Process

In the last few years, a new area of research in PSEs has involved the better definition of the software process which PSEs are intended to support. As with the methods, there are too many such efforts to list here, but they are sure to play an important role in determining the sort of PSE needed to support those that are emerging.

## 5.4 Interface Standards

### CAIS

The Common Ada Programming Support Environment (APSE) Interface Set (CAIS) (MIL-STD-1838A) is a set of Kernel APSE (KAPSE) level interfaces designed to provide a portability base for tools written in Ada. It is in the form of Ada packages. The CAIS provides services for a typed object management system, process management (including transactions) and various levels of input/output. Point of contact: Duston Hayward, Code 411, NOSC, San Diego, CA 92152-5000, (619) 553-4067.

### Portable Common Tool Environment (PCTE)

PCTE is a European product very similar in nature to CAIS. It addresses the same level of interface and the same sorts of concerns. Originally developed by an industry consortium, it has become the target of standardization by the European Computer Manufacturers Association and has been adopted and enhanced by a group of European MODs. Point of contact: Ken Hayter, CCR, N132, Royal Signals and Radar Establishment, St. Andrews Road, Great Malvern, Worcs WR14 3PS, United Kingdom, +44-(0684)-895836.

### Portable Common Interface Set (PCIS)

PCIS is a project, in its first stages of organization, whose objective is to achieve a merger of CAIS and PCTE (described above). It enjoys the participation of most of the NATO nations. It is expected that PCIS will provide a smooth transition from either CAIS or PCTE for organizations which make a commitment now to either of those. A new specification is targeted for completion during FY94. Point of contact: Currie Colket, AJPO, (703)614-0209 or Ken Hayter (listed above for PCTE).

### Portable Operating System for Computer Environments (POSIX)

IEEE Standard 1003, IEEE Standard Portable Operating System for Computer Environments, is an attempt to define a standard operating system interface and environment based on the UNIX Operating System. They are to develop documentation to support application portability at the source level. This is intended for systems implementers and applications software implementers. There are several subgroups within IEEE Standard 1003 considering issues such as security, real-time, verification and Ada interfaces. POSIX is steadily expanding to address a wise variety of computer system needs, based largely on a concept of profiling which provides the framework for bringing together number of complementary standards to fulfill the needs of some particular application area. Among the profiles currently identified and being pursued is one for "software development environments". Point of contact: Roger Martin, NIST, Building 225, Room 8266, Gaithersburg, MD 20899, (301)975-3295.